DIVERSION EFFECTS ON FISH

APPENDIX A

CALFED ALTERNATIVE EVALUATION FOR CENTRAL VALLEY SALMON SURVIVAL WITHIN THE DELTA

DIVERSION EFFECTS ON FISH

CALFED ALTERNATIVE EVALUATION FOR CENTRAL VALLEY SALMON SURVIVAL WITHIN THE DELTA NARRATIVE

Draft - June 23, 1998

In this report, we describe an analysis of diversion effects on Central Valley chinook salmon within the Delta. Our assignment was to evaluate variations in the survival of chinook salmon within the Delta for each of several scenarios being considered in the CALFED Program. The scenarios are No Action, Common Programs and Alternatives 1, 2, and 3, and are evaluated in relation to Existing Conditions. Our evaluation is based on one operation study for each scenario. Because variations in operations could result in considerable differences in effects on chinook salmon within the Delta, our analysis provides only a first approximation of potential differences among scenarios.

We evaluated the effects of CALFED water storage and conveyance alternatives on chinook lifestages in the Delta; we did not evaluate overall effects on chinook population dynamics. An analysis of survival throughout the entire Sacramento and San Joaquin basins, in the Delta and Bay, and in the ocean would be necessary to assess the effects of the CALFED program on overall chinook population dynamics. Evaluation of effects on survival upstream from the Delta would be particularly important for the CALFED Ecosystem Restoration and Water Quality Programs. Evaluation of effects of ocean conditions and commercial and recreational harvests would be important to provide an appropriate perspective on impacts in the ocean. Although our within-Delta analysis is not sufficient to evaluate the effects of the entire CALFED program, it is sufficient to describe the full effects of the alternative ways of transferring water across the Delta being considered in the CALFED Programmatic Environmental Impact Statement.

We prepared separate analyses for chinook salmon from the Sacramento and San Joaquin systems, because of their different uses of the estuary. From the San Joaquin system, only one race, fall run, is involved. From the Sacramento system, four races are involved, each juvenile lifestage using the estuary to a different extent and during a distinctive time period, collectively using the estuary in every month except July. (In August, estuary use is limited to adults immigrating upstream, and the subcommittee identified no adverse effects.)

Two of the races, the Sacramento winter and spring runs, are receiving protection under endangered species laws and thus require special consideration in making management decisions. At this stage, the subcommittee's analysis integrates effects over all runs, without separately identifying effects on the listed runs.

We first analyzed the effects (by month) of parameters expected to influence salmon survival in the Delta. We used the results of this analysis to answer a series of questions posed by CALFED. This report includes both a description of our analysis and answers to CALFED's questions.

The subcommittee is co-chaired by Patricia Brandes, U. S. Fish and Wildlife Service and Sheila Greene, Department of Water Resources. Other biologists participating fully throughout the analysis were Serge Birk, Central Valley Project Water Association, Pete Chadwick, Department of Fish and Game, Karl Halupka, U. S. National Marine Fisheries Service, Jim Starr, Department of Fish and Game, and Jim White, Department of Fish and Game.

METHODS

We developed a matrix for each CALFED scenario. All matrices consist of rows for each parameter expected to affect salmon survival in the Delta, and columns for each month and the sum of all months (Appendix A, pages A15-A20). We assign an integer value to each matrix cell reflecting the relative magnitude of adverse or beneficial effects of each parameter on the population of juvenile chinook in the Delta in each month. We scored Existing Conditions first, and then sequentially No Action, Common Programs, and Alternatives 1, 2, and 3. We completed two analyses for Alternatives 1, 2, and 3; for the alternatives with no additional storage and for the alternative with the maximum amount of storage being considered by CALFED. Initially, under Existing Conditions, integer values ranged from -3 to +3, but for matrices that were scored subsequent to Existing Conditions, values ranged outside -3 to +3 to maintain a consistent assessment of magnitude of effect relative to Existing Conditions.

The primary goal of scoring the Existing Conditions matrix is to obtain a set of consensus values that accurately describe present conditions. These values subsequently serve as a baseline for comparison with other scenarios. We assign Existing Conditions values that we consider reasonable in relation to limiting factors, without making any attempt to relate values to some specific set of historical conditions. We do not attempt to define "recovery," "restoration," or any other potential CALFED goals.

We consider both the magnitude of effect of each parameter and the proportion of the population present in the Delta in determining the value for each cell in the matrix. For example, a parameter causing a small change on a large proportion of the population could have the same population effect as a parameter causing a large change on a small proportion of the population, and thus could receive the same value.

We used best professional judgement to determine the degree to which each parameter affects salmon survival. We considered empirical relationships between parameters and survival, when relationships were available. Our evaluations were based on qualitative assessments of the degree to which water operations, water management facilities, and biological factors affect chinook salmon in the Delta.

For the Sacramento system, we consider each of the four races of chinook and their occurrence in the Delta as fry, smolts and yearlings. We integrate effects over all life stages of all races, including returning adults immigrating through the Delta, to determine values for each matrix cell.

To clarify and summarize the results in the matrix analysis, we created composite parameters (Tables 2 and 3; Appendix A, pages A15-A20). One composite parameter is Entrainment Losses. It is an estimate of losses occurring immediately in the vicinity of export diversions, either at the SWP and CVP south Delta diversions or at a new Hood facility. The overall estimate of Entrainment Losses is based primarily on the Percent Exposed parameter. If the sum of the other three entrainment related parameters (Screen efficiency/Predation, Trucking/ Handling and Clifton Court Forebay Loss) exceeds 3, we adjust the Percent Exposed parameter by -1 to reflect increase severity of Entrainment Losses.

Another composite parameter is Interior-Delta Survival. It is the survival of juvenile salmon diverted from the mainstem Sacramento River into the Mokelumne and San Joaquin portions of the Delta, and juvenile salmon emigrating through the San Joaquin portions of the Delta, exclusive of Entrainment Losses. Interior-Delta Survival is the sum of Flow Distribution, Delta Cross Channel, Predation, Temperature, and Salinity. Flow Distribution is based on flows in Old and Middle Rivers and San Joaquin River downstream of the Mokelumne River in the DSMII operation studies. Old and Middle Rivers connect the lower San Joaquin River to the south Delta export facilities.

We make separate estimates for the five component parameters under Interior-Delta Survival to reflect some knowledge of the independent effects of individual parameters, but are more certain of the overall estimate of Interior-Delta Survival than the values of the individual parameters. Our increased certainty is based on extensive smolt release and recapture experiments using hatchery smolts. Paired experiments result in an estimate of differential survival of smolts released simultaneously in the mainstem Sacramento River and in the Interior Delta, and subsequently recaptured downstream of the Delta. We recognize the survival of hatchery smolts probably does not reflect the survival of wild smolts precisely. Although the experiments were not designed to identify the sources of decreased survival, we assumed the sources to be the five parameters under Interior-Delta Survival. The results of the paired experiments were that survival of smolts diverted into the interior Delta was one third or less of the survival of smolts remaining in the mainstem Sacramento River (Table 1). The small proportion of chinook salvaged at the CVP and SWP south Delta exports indicates most of the decrease in survival is due to Interior-Delta Survival rather than Entrainment Losses.

Among the component parameters under Interior-Delta Survival, a majority of the subcommittee considers the Flow Distribution parameter to be a surrogate for effects associated with flow and olfactory cues, which are believed to be related to survival indirectly through mechanisms such as influencing the duration of emigration. Members of the committee all agree that the Flow Distribution effects are greatest near the south Delta export facilities when pumping rates are greatest. There is not consensus as to how widespread the effects are, and in particular whether they extend to the San Joaquin River in the central Delta where tidal flows far exceed net freshwater flows. Also, a minority of the subcommittee recommended it would be more appropriate to distribute some of the magnitude of effects represented in the Flow Distribution parameter among the other component parameters, such as, predation, temperature and salinity.

We based our evaluations on a single operation study for each scenario. The specific CALFED operation studies used for each scenario are: Existing Conditions - 558, No Action - 516, Alternative 1 without storage - 518, Alternative 1 with storage - 609, Alternative 2 without storage - 528, Alternative 2 with storage - 532a, Alternative 3 without storage - 595, and Alternative 3 with storage - 567. Flow changes associated with the Common Programs were evaluated by comparing flows below Hood and at Rio Vista in study 518 to flows in studies 516 and 518, and from tables in Appendix E of the 19 May 1998, draft modeling studies. The operation studies consist of flows at selected locations in the Delta, computed on a monthly timestep, then averaged over all years from 1922 to 1994, dry and critical years, and other

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subsets. We recognized the pitfalls associated with using average values, but we did not have time to explore fully, or to consider scoring, the full range of annual variability.

One of the parameters included in the matrices is Toxics. Acute and chronic toxic effects have been identified in the Delta, but results of standard toxicity bioassays have not been related directly to salmon in ways that the subcommittee felt competent to judge. Such effects would be expected to change due to the CALFED Water Quality Program, but that program is not yet described with sufficient specificity to judge how it might affect salmon. Water quality differences may also occur among alternatives due to differences in dilution in different areas of the Delta, or due to changes in the toxic constituents delivered to the Delta associated with changes in proportional flow from the Sacramento and San Joaquin rivers. The subcommittee did not feel competent to offer judgements on any of these aspects of toxicity.

In the matrices, the sum of all months is the overall annual effect of each parameter. Upon examining annual estimates for some parameters, or groups of parameters, in the Sacramento matrices, the subcommittee concluded that some parameters were not weighted properly in relation to other parameters. In such cases, the subcommittee divided or multiplied the annual estimate by a constant to provide the proper relationship among parameters or groups of parameters. Only the annual estimates were weighted in that fashion, so the reader needs to use caution in reaching conclusions based on comparing monthly values. For the San Joaquin system, weighting among parameters was incorporated directly as cells were assigned monthly values.

Two weighting factors were applied to the results of Sacramento River evaluations. When we compared the annual estimates for Entrainment Losses (-20) to the annual estimate for Interior-Delta Survival (-30), we concluded that this reflects an over weighting of Entrainment Losses (Table 2). Dividing Entrainment Losses by 4 brought them roughly into balance with empirical evidence on the relative effects on survival of these two parameters. Entrainment Losses in all Sacramento matrices were weighted in this fashion.

We identified another weighting disparity between relative magnitudes of Interior-Delta Survival and Flow below Hood in the Sacramento River. We concluded that Flow Below Hood should be multiplied by 2 to make the annual estimates for that parameter similar in range to the annual estimates for Interior-Delta Survival. Our justification for weighting survival in the Sacramento River and in the interior Delta nearly the same is that about four times as many salmon remain in the Sacramento River with the Delta Cross Channel gates closed as are diverted into the Delta, but the survival rate of juvenile salmon diverted into the interior Delta is reduced to one third or less of the rate for smolts that remain in the Sacramento River (Table 1).

RESULTS

Chinook Salmon From The Sacramento System

Existing Conditions

In summary, we determined that Existing Conditions have negative impacts primarily due to decreased Interior-Delta Survival and Entrainment Losses, both being substantial in all months except July and August.

No Action

We concluded that the only substantial difference in comparison to Existing Conditions was due to increases in exports of about 10% annually. The result of increased exports were shown as small increases in Entrainment Losses in January and February and small decreases in Interior-Delta Survival in December and January (Table 2).

Common Programs

The Common Programs that we judged would have some effect on survival of Sacramento salmon were the flow augmentations, wetland and riparian restoration (which translated into decreased predation, more extensive shallow water habitat, and enhanced food supply in the analysis), and agricultural diversion screening components of the Ecosystem Restoration Program (Table 2). We believe the effect of a flow augmentation of about 5% in March and May would be marginal in the Delta in relation to the other parameters' effects, therefore we increased the value of Flow Below Hood only during May in the matrix.

The relative effects of wetland and riparian restoration programs were difficult to judge. Where these habitats are available, they are used by juvenile salmon as rearing habitat, and provide both terrestrial and aquatic foods for both rearing and emigrating juvenile salmon. These habitats also would be likely to increase the abundance of predators, but most biologists agree that some net benefits would occur for salmon. We are not aware of experimental evidence that estimates the magnitude of such benefits. In the Ecosystem Restoration Program, CALFED proposes moderate increases in existing habitat in the Delta. It is not clear, however, how restored habitat will be distributed. Benefits would likely be greater than those we estimated if the habitat were concentrated in migration corridors for salmon. We concluded that restored habitat would provide modest rearing benefits, primarily from December through March, food supply benefits from December through May, and reduced in-Delta predation from March through May.

We estimated that screens on Delta agricultural diversions would reduce existing impacts in April, May, and June.

Alternative 1

We concluded that the primary changes in relation to Existing Conditions, beyond those attributable to the Common Programs, would be small decreases in Entrainment Losses (Table 2). The new fish screens at the intake to Clifton Court Forebay for both the CVP and SWP would improve screen efficiencies and eliminate predation losses now occurring in Clifton Court Forebay. Under Alternative 1 with storage, this improvement would be offset, to some degree, by exposure of a greater number of salmon to the screens from December through March, and decreased Interior-Delta Survival from October through March, due to increased exports.

Alternative 2

Several substantial changes would occur under Alternative 2 (Table 2). First, Entrainment Losses would increase. This would result from the combination of exposure to a new diversion at Hood and continued exposure to diversions in the south Delta. The fraction exposed to a diversion at Hood would be substantially greater than the fraction exposed now to the diversions in the south delta. The fraction exposed in the south Delta would not change much, as a result of a fairly complicated set of interactions. A larger fraction of the salmon would be diverted into the interior Delta, due to the lower flows below Hood intake increasing both the density of salmon in the Sacramento River and the proportion of flow diverted through

Georgiana Slough into the interior Delta. The increase would be more or less offset by more favorable flows in the interior Delta causing a smaller fraction of the salmon to go to the south Delta diversion and a larger fraction to migrate west towards the ocean.

A second adverse effect would be the Flow below Hood in the Sacramento River. The subcommittee expects this would decrease survival from September through June, with the greatest reductions occurring when the greatest fraction of flow is being diverted at Hood and when the flows are the lowest.

A third adverse effect would be the need to pass adult salmon migrating upstream through the San Joaquin-Mokelumne route to the Sacramento River. These fish would have to pass the Hood fish screen and pumping plant. While a bypass facility would be built, we determined it would probably impose new impacts on the adult population.

A beneficial effect under Alternative 2 would be improved Interior-Delta Survival for salmon smolts diverted through Georgiana Slough, due to more favorable flow distribution in the San Joaquin River and the avoidance of any need to open the Delta Cross Channel gates.

Alternative 3

This Alternative would not have the adult salmon passage problems at the Hood fish screens and pumping plant as would occur with Alternative 2. Otherwise the changes would parallel those for Alternative 2.

Entrainment Losses would increase (Table 2) for the same reasons described for Alternative 2, but the increases would be less than in Alternative 2, because exports from the south Delta would be reduced by about 80% and water diverted into Georgiana Slough would be distributed more favorably.

Survival in the Sacramento River below Hood would be reduced by essentially the same amount as for Alternative 2.

Interior-Delta survival would be even better than for Alternative 2, due to better flow distribution in the San Joaquin River.

Chinook Salmon from the San Joaquin System

Existing Conditions

Salmon from the San Joaquin system use the Delta over a smaller portion of the year than salmon from the Sacramento system (Appendix 2). Adults migrate upstream in the fall, some fry move downstream in January and February to rear in the Delta, and most of the juveniles emigrate downstream as smolts from March through June.

Entrainment Losses in the south Delta are controlled by the same parameters as those that control Entrainment Losses for salmon from the Sacramento, but the proportion of the population exposed to the screens is much greater because the screens are directly on their migratory pathway.

Interior-Delta Survival is also controlled by similar parameters, except that opening the Delta Cross Channel gates does not have a direct impact, but a barrier at the head of Old River reduces impacts.

Flows at Vernalis replace flows below Hood as a parameter. Flows at Vernalis have been shown to be correlated to escapement two and a half years later (Kjelson, Brandes, 1989). In addition, the survival of CWT smolts released in the south Delta is positively correlated to flow at Stockton and Vernalis (IEP Newsletter, Winter 1998).

Flows during the fall are inadequate for adult attraction and upstream passage. Entrainment Losses, Flows at Vernalis and Interior-Delta Survival are all of concern from January through June. Measures prescribed in the VAMP agreement and the head of Old River barrier partially mitigate adverse conditions in April and May.

No Action

Conditions are similar to Existing Conditions, except for slightly greater Entrainment Losses and poorer Flow Distribution in January and February (Table 3).

Common Programs

As for the Sacramento system, screening Agricultural Diversions and creating wetland and riparian habitat as part of the Ecosystem Restoration Program provide benefits of the same magnitude, and subject to the same caveats as those described for the Sacramento system (Table 3). In addition, flow augmentation provided as part of the Ecosystem Restoration Program are expected to improve conditions in May.

Alternative 1

New screens at the intake to Clifton Court Forebay would substantially reduce Entrainment Losses particularly for Alternative 1 without storage (Table 3). For this alternative with storage, Flow Distribution would become somewhat worse in January through March.

Alternative 2

In comparison to Alternative 1, Interior-Delta Survival would improve due to improved Flow Distribution downstream from the mouth of the Mokelumne River (Table 3). Otherwise conditions would be similar to those for Alternative 1.

Alternative 3

Reductions in diversions from the south Delta by about 80% would substantially reduce Entrainment Losses and improve Interior-Delta Survival due to Flow Distribution throughout the San Joaquin Delta being even more favorable than in Alternative 2 (Table 3). These changes would improve conditions both for adults migrating downstream and for young rearing in the Delta and migrating downstream.

QUESTIONS

1. Which population or life stages are most sensitive to diversion effects under no action and Alternatives 1, 2, and 3? When and where are they most affected?

Under the No Action Alternative, the San Joaquin basin chinook would be more vulnerable to effects of diversions from the south Delta than Sacramento chinook. All San Joaquin chinook migrate through the south Delta, where they are highly susceptible to direct entrainment, predation in Clifton Court Forebay, and reduced survival associated with unfavorable flow distribution in the southern and a much smaller proportion of the population of Sacramento chinook are affected by diversions from the south Delta.

Under Alternative 1, San Joaquin and Sacramento chinook Entrainment Losses would be reduced by elimination of Clifton Court Forebay predation, although the altered flow distribution still would affect San Joaquin and Sacramento chinook through prolonged exposure to a variety of mortality sources in the Delta.

Under Alternative 2, the entire population of Sacramento chinook would emigrate past Hood and thus would be exposed to a screened diversion at Hood and to reductions in flow in the Sacramento River downstream from Hood. The San Joaquin and Sacramento chinook that would emigrate through the interior Delta would still be affected by changes in interior-Delta hydrodynamics, although to a lesser degree than in Alternative 1, because of the increased frequency of net downstream flows below the mouth of the Mokelumne River. An effect unique to Alternative 2 would be that adult salmon returning to the Sacramento basin that have been attracted to the Mokelumne River portion of the Delta would be affected adversely due to delays in migration and other impacts at whatever fish passage facility would be constructed at Hood to return these salmon to the Sacramento River.

Under Alternative 3, San Joaquin chinook would benefit from restored flow distribution patterns in the south and central Delta, reduced pumping, and improved screens in the south Delta. Sacramento chinook would still be adversely affected by reduced flows in the Sacramento River. The effect of altered flow distribution on the survival of salmon that enter the interior Delta would be better than for Alternatives 1 or 2.

Juvenile chinook are considered to be at greatest risk to diversion effects due to their need to find their way through the Delta to the ocean. Yearlings and smolts are considered more subject to diversion effects than rearing fry, because they are actively migrating. Fry rearing in the Delta are important to salmon production, especially in wet years, and their survival depends on conditions over a several month period prior to their migrating to the ocean as smolts. During their emigration, they are presumably just as subject to diversion effects as smolts entering the Delta after rearing in upstream areas.

2. Can diversion effects in the South Delta be offset by habitat improvements and other common program actions?

Modest benefits for juvenile chinook were estimated due to enhanced food supply and physiological condition, reduced toxicity, reduced entrainment in small diversions, and more extensive rearing and escape habitat associated with the ERP element of the Common Programs.

Considerable uncertainty surrounds how the ERP will be implemented and thus the magnitude of associated benefits. The presumed benefit for salmon from improvement or type conversion of existing habitat is proportionally modest. If the ERP emphasized improving habitat along migration corridors for salmon, benefits would be greater than estimated in this analysis. Increased flows in March and May in the Sacramento River and in May in the San Joaquin River provided by the ERP would provide a minor improvement in chinook survival in the Delta, in addition to the benefits that would be expected upstream of the Delta. Overall, we concluded that the common programs would not provide enough benefits in the Delta to offset fully diversion effects.

The subcommittee did not attempt to estimate benefits to salmon from the Water Quality Program.

3. **To what extent can Alternatives 1, 2 and 3 offset diversion effects as presently configured?**

Our answer to question 1 answers this question as well.

4. **To what extent can diversion effects be offset by modifications to the Alternatives or by operational changes?**

The subcommittee has not addressed this question.

5. **What is the risk and chances of success of species recovery for each alternative?**

The probability for recovery depends on conditions throughout the life history of salmon. Because the subcommittee considered only needs of young and adults in the Delta, the following answers only partially address the question of recovery.

No Action- The No Action scenario continues to rely on closure of the Delta Cross Channel gates from November through June to improve the survival of salmon migrating down the Sacramento River. This has a high risk of conflict with water supply operations during low flow periods.

The ongoing efforts of the Ops Group to improve salmon survival under Existing Conditions in the face of limited operational flexibility indicates that very little "recovery" potential would exist under the No Action scenario.

Common Programs- See the answer to Question 2.

Alternative 1- As with the No Action scenario, reliance on closure of the Delta Cross Channel gates would continue.

Experience with fish screen operations in the south Delta indicate a high probability that the benefits expected from improved fish screens would be achieved. Such benefits are limited by the need for continued handling and trucking, but experimental evidence indicates this is less of a risk for salmon than for many other species.

Alternative 1 includes measures such as the Water Use Efficiency and Water Transfer programs, which would somewhat increase flexibility in water supply operations. Thus Alternative 1 offers some potential for shifting diversions to times less detrimental to salmon, but such shifts would be likely to increase impacts on other species, would sometimes interfere with water supply benefits, and probably would not be sufficient to cause major improvements in salmon production.

Overall, Alternative 1 is not likely to result in significant increases in survival for salmon from the Sacramento system.

For the San Joaquin, Alternative 1 would increase salmon survival somewhat, due to the improved structure and location of the fish screens.

Alternative 2- Risks for new screens in the south Delta are the same as described for Alternative 1. Several new risks for salmon from the Sacramento system are inherent in Alternative 2 associated with the diversion at Hood. One is the fish screens themselves. Advances in fish screen design provide good evidence that a successful screen can be built, but all large fish screens have inherent risks. Even the best screen would increase the risk for salmon from the Sacramento system, due to the greater exposure of the population to the screen. Also, the screen and the pumping plant that would accompany it would pose a new risk for adults migrating upstream. Finally, the diversion would reduce flows in the Sacramento River below Hood. The subcommittee recognized considerable uncertainty in the consequences of that reduction, based both on questions about evidence of the effects on survival and about the magnitude of flow reductions that would occur over the range of operating conditions. The subcommittee, however, believes that Alternative 2 would pose risks for salmon from the Sacramento system greater than any other alternative. For salmon from the San Joaquin, Alternative 2 would be intermediate between Alternatives 1 and 3.

Alternative 3- San Joaquin basin chinook have the greatest potential to benefit from Alternative 3, but the improvement may not ensure "recovery". Flows at Vernalis are strongly correlated to population levels of San Joaquin salmon, and although the Alternatives would improve San Joaquin flows as a result of ERP flows and VAMP, the improvements in survival are expected to be small.

The benefits that are most certain are the reduction in entrainment losses associated with the large reduction in diversions from the south Delta. Those benefits would be greatest for San Joaquin stocks and for those smolts diverted into the central Delta from the Sacramento River via Georgiana Slough.

Alternative 3 would not have the risk for upstream migrants that Alternative 2 would have because there are no attraction flows for adults in the central Delta. Other risks of the Hood diversion would be essentially the same as those described for Alternative 2.

6. What increment of protection or improvement for fish species will be provided by other programs such as the CVPIA, biological opinions?

The increment of improvement for the various programs is difficult to quantify, but if most of the actions contained within the Anadromous Fish Restoration Plan are implemented, substantial improvement should be achieved. The CALFED program, as it is proposed, would include restoration elements not included in CVPIA and the Winter Run and Delta Smelt Biological Opinions.

7. What degree of benefit and impact will the common programs provide?

We estimated that improvement would occur with the common programs. Much of the benefit predicted is due to the creation of additional shallow water habitat of several different types. The effect on salmon is uncertain, largely due to the scarcity of evidence regarding the ecological tradeoffs associated with increasing restored habitat area in an aquatic ecosystem dominated by introduced species. Salmon, particularly presmolts, are likely to use restored habitat. Although the habitat will also be favorable for predators, the increased cover and food supply will increase salmon survival in the opinion of most salmon biologists. Screening Delta diversions and improved Delta water quality are also expected to be beneficial.

8. What are the direct and indirect effects on chinook populations resulting from each Alternative and what is the expected response of the populations to these effects?

The Results section and summary tables included in this report address this question. However, the subcommittee is concerned that some readers may focus on the summarized information without appreciating the imprecision and uncertainties involved. The numbers in the summary tables should be interpreted carefully and are most appropriately used to support broad generalizations such as those offered after the summaries. Imprecision and uncertainty are involved throughout, and the subcommittee is particularly concerned with Flow Below Hood and Interior-Delta Survival. We did not have adequate time to explore and cite the available evidence to the degree that we would have liked, and even if we had, considerable uncertainty would remain as to both the magnitude of effects and the controlling mechanisms.

The annual sums are useful for gross comparisons among scenarios, but the monthly evaluations are essential for more fully understanding the scenarios and formulating alternative operations.

A summary for the Sacramento system (Table 1) is that compared to Existing Conditions the Common Programs would provide a substantial benefit, but some negative consequences would persist. With Alternatives 1 and 3, approximately the same net magnitude of consequences would persist as with the Common Programs, but for quite different reasons. For Alternative 1 there would be little change from the Common Programs for any category of parameters, and for Alternative 3, our estimate of improvements in Interior-Delta Survival would be offset by detriments from flow reductions below Hood. For both Alternatives 2 and 3, the consequences of flow reductions below Hood would vary considerably depending on the magnitude of flow. In high flow periods, effects might be inconsequential, but in low flow periods, survival would probably be less than the approximation of the overall average included in the summary.

A summary for the San Joaquin system (Table 2) is that compared to Existing Conditions the Common Programs would provide benefits similar to those provided for the Sacramento system. As in the Sacramento system, Alternative 1 would provide little change from the Common Programs. For Alternatives 2 and 3 the consequences would be quite different than for the Sacramento system. Alternative 3 would clearly be superior, and Alternative 2 would provide intermediate benefits.

Table 1
Survival indices to Chipps Island for coded wire tagged fall run smolts and late-fall run yearlings released at Ryde and in Georgiana Slough between 1992 and 1996.

Fall run

Date	Ryde	Georgiana Slough	Ratio (GS/R)
4/6/92	1.36	0.42	0.30
4/14/92	2.14	0.73	0.34
4/27/92	1.67	0.20	0.12
4/14/93	0.41	0.13	0.31
5/10/93	0.86	0.29	0.33
4/12/94	0.20	0.06	0.30
4/25/94	0.18	0.11	0.61
		Mean	= 0.33

Late fall

Date	Ryde	Georgiana Slough	Ratio (GS/R)
12/2/93	1.91	0.28	0.14
12/5/94	0.57	0.16	0.28
1/4/95	0.33	0.12	0.36
1/10/96	0.66	0.17	0.25
1/13/98*	0.90	0.24	0.27
12/4/97*	0.70	0.03	0.04
		Mean =	0.22

* Preliminary data

Table 2

Summary of matrices evaluating the effects in the Delta on chinook salmon from the Sacramento River basin. Alternatives 1, 2, and 3 were evaluated without any new storage and with maximum new storage contemplated by CALFED (results are presented: without/with).

Effects	Existing	No Action	Common	Alt. 1	Alt. 2	Alt. 3
Entrainment Losses	-5	-6	-6	-4 / -5	-7 / -8	-6 / -7
Flow below Hood	-6	-6	-4	-4	-28	-28
Interior-Delta Survival	-30	-32	-25	-25 / -31	-7 / -12	0
Shallow water habitat, food supply & ag diversion screens	-3	-3	+10	+10	+10	+10
Upstream migration of adult salmon	0	0	0	0	-19	0
Total	-44	-47	-25	-23 / -30	-51 / -57	-24 / -25
Change from existing conditions		-3	+19	+21 /+14	-7 / -13	+20 /+19
Change from Common Programs				+2 / -5	-26 / -32	+1 / 0

Table 3
Summary of matrices evaluating the effects in the Delta on chinook salmon from the San Joaquin River basin. Alternatives 1, 2, and 3 were evaluated without any new storage and with maximum new storage contemplated by CALFED (results are presented: without/with).

Effects	Existing	No Action	Common	Alt. 1	Alt. 2	Alt. 3
Entrainment Losses	-12	-13	-13	-7 / -10	-7 / -10	-2 / -2
Vernalis flow	-18	-18	-17	-17	-17	-17
Interior-Delta Survival	-23	-25	-19	-19 / -22	-2 / -5	+14 /+14
Shallow water habitat, food supply & ag diversion screens	-3	-3	+8	+8	+8	+8
Total	-56	-59	-41	-35 / -41	-18 / -24	+3 / +3
Change from existing conditions		-3	+15	+21 /+15	+38 /+32	+59 /+59
Change from Common Programs				+6 / 0	+23 /+17	+44 /+44

EXISTING CONDITIONS (Baseline)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep		SUM	Mod	MOD SUM
Entrainment	-1	-2	-2	-1	-1	-3	-3	-3	-2	0	0	-2		-20	/4	-5
													sum			
% Population Exposed	-1	-2	-2	-1	-1	-2	-2	-2	-1	0	0	-1	-15			
Screen Efficiency/Predati	0	0	-1	-1	-1	-1	-1	-1	-1	-1	-1	0	-9			
Handling/Trucking Losse	0	0	0	0	0	0	0	-1	-1	-1	-1	-1	-5			
CCFB Predation Losses	-2	-1	-1	-1	-1	-2	-3	-3	-3	-3	-3	-3	-26			
Interior Delta Survival	-2	-3	-5	-3	-2	-3	-2	-4	-5	0	0	-1		-30	na	-30
													sum			
Flow Distribution	-1	-2	-3	-2	-1	-1	0	0	-1	0	0	-1	-12			
Cross Channel Operation	-1	-1	-1	0	0	0	0	0	-1	0	0	0	-4			
Predation in the Delta	0	0	-1	-1	-1	-2	-2	-2	-1	0	0	0	-10			
Temperature	0	0	0	0	0	0	0	-2	-2	0	0	0	-4			
Salinity	0	0	0	0	0	0	0	0	0	0	0	0	0			
Flow below Hood	0	0	0	0	0	0	-1	-1	-1	0	0	0		-3	x2	-6
Shallow Water Habitat	0	0	0	0	0	0	0	0	0	0	0	0		0		0
Food Supply	0	0	0	0	0	0	0	0	0	0	0	0		0		0
Ag Diversions	0	0	0	0	0	0	-1	-1	-1	0	0	0		-3		-3
Adult migration	0	0	0	0	0	0	0	0	0	0	0	0		0		0
Toxics (dilution/inputs)	*	*	*	*	*	*	*	*	*	*	*	*		0		0
													TOTAL	-56		-44

NO ACTION ALTERNATIVE

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep		SUM	Mod	MOD SUM
Entrainment	-1	-2	-2	-2	-2	-3	-3	-3	-2	0	0	-2		-22	/4	-6
													sum			
% Population Exposed	-1	-2	-2	-2	-2	-2	-2	-2	-1	0	0	-1	-17			
Screen Efficiency/Predati	0	0	-1	-1	-1	-1	-1	-1	-1	-1	-1	0	-9			
Handling/Trucking Losse	0	0	0	0	0	0	0	-1	-1	-1	-1	-1	-5			
CCFB Predation Losses	-2	-1	-1	-1	-1	-2	-3	-3	-3	-3	-3	-3	-26			
Interior Delta Survival	-2	-3	-6	-4	-2	-3	-2	-4	-5	0	0	-1		-32	na	-32
													sum			
Flow Distribution	-1	-2	-4	-3	-1	-1	0	0	-1	0	0	-1	-14			
Cross Channel Operation	-1	-1	-1	0	0	0	0	0	-1	0	0	0	-4			
Predation in the Delta	0	0	-1	-1	-1	-2	-2	-2	-1	0	0	0	-10			
Temperature	0	0	0	0	0	0	0	-2	-2	0	0	0	-4			
Salinity	0	0	0	0	0	0	0	0	0	0	0	0	0			
Flow below Hood	0	0	0	0	0	0	-1	-1	-1	0	0	0		-3	x2	-6
Shallow Water Habitat	0	0	0	0	0	0	0	0	0	0	0	0		0		0
Food Supply	0	0	0	0	0	0	0	0	0	0	0	0		0		0
Ag Diversions	0	0	0	0	0	0	-1	-1	-1	0	0	0		-3		-3
Adult migration	0	0	0	0	0	0	0	0	0	0	0	0		0		0
Toxics (dilution/inputs)	*	*	*	*	*	*	*	*	*	*	*	*		0		0
													TOTAL	-60		-47

COMMON PROGRAMS

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep		SUM	Mod	MOD SUM
Entrainment	-1	-2	-2	-2	-2	-3	-3	-3	-2	0	0	-2		-22	/4	-6
													sum			
% Population Exposed	-1	-2	-2	-2	-2	-2	-2	-2	-1	0	0	-1	-17			
Screen Efficiency/Predati	0	0	-1	-1	-1	-1	-1	-1	-1	-1	-1	0	-9			
Handling/Trucking Losse	0	0	0	0	0	0	0	-1	-1	-1	-1	-1	-5			
CCFB Predation Losses	-2	-1	-1	-1	-1	-2	-3	-3	-3	-3	-3	-3	-26			
Interior Delta Survival	-2	-3	-5	-3	-1	-2	-1	-3	-4	0	0	-1		-25	na	-25
													sum			
Flow Distribution	-1	-2	-4	-3	-1	-1	0	0	-1	0	0	-1	-14			
Cross Channel Operation	-1	-1	-1	0	0	0	0	0	-1	0	0	0	-4			
Predation in the Delta	0	0	0	0	0	-1	-1	-1	0	0	0	0	-3			
Temperature	0	0	0	0	0	0	0	-2	-2	0	0	0	-4			
Salinity	0	0	0	0	0	0	0	0	0	0	0	0	0			
Flows below Hood	0	0	0	0	0	0	-1	0	-1	0	0	0		-2	x2	-4
Shallow Water Habitat	0	0	1	1	1	1	0	0	0	0	0	0		4		4
Food Supply	0	0	1	1	1	1	1	1	0	0	0	0		6		6
Ag Diversions exposure)	0	0	0	0	0	0	0	0	0	0	0	0		0		0
Adult migration	0	0	0	0	0	0	0	0	0	0	0	0		0		0
Toxics (dilution/inputs)	*	*	*	*	*	*	*	*	*	*	*	*		0		0
													TOTAL	-39		-25

ALTERNATIVE 1 (without storage)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep		SUM	Mod	MOD SUM
Entrainment	-1	-2	-2	-2	-2	-2	-2	-2	-1	0	0	-1		-17	/4	-4
													sum			
% Population Exposed	-1	-2	-2	-2	-2	-2	-2	-2	-1	0	0	-1	-17			
Screen Efficiency/Predati	0	0	0	0	0	0	-1	-1	-1	-1	-1	0	-5			
Handling/Trucking Losse	0	0	0	0	0	0	0	-1	-1	-1	-1	-1	-5			
CCFB Predation Losses	0	0	0	0	0	0	0	0	0	0	0	0	0			
Interior Delta Survival	-2	-3	-5	-3	-1	-2	-1	-3	-4	0	0	-1		-25	na	-25
													sum			
Flow Distribution	-1	-2	-4	-3	-1	-1	0	0	-1	0	0	-1	-14			
Cross Channel Operation	-1	-1	-1	0	0	0	0	0	-1	0	0	0	-4			
Predation in the Delta	0	0	0	0	0	-1	-1	-1	0	0	0	0	-3			
Temperature	0	0	0	0	0	0	0	-2	-2	0	0	0	-4			
Salinity	0	0	0	0	0	0	0	0	0	0	0	0	0			
Flows below Hood	0	0	0	0	0	0	-1	0	-1	0	0	0		-2	x2	-4
Shallow Water Habitat	0	0	1	1	1	1	0	0	0	0	0	0		4		4
Food Supply	0	0	1	1	1	1	1	1	0	0	0	0		6		6
Ag Diversions	0	0	0	0	0	0	0	0	0	0	0	0		0		0
Adult Migration	0	0	0	0	0	0	0	0	0	0	0	0		0		0
Toxics (dilution/inputs)	*	*	*	*	*	*	*	*	*	*	*	*		0		0
													TOTAL	-34		-23

ALTERNATIVE 2 (without storage)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep		SUM	Mod	MOD SUM
Entrainment	-2	-4	-4	-3	-2	-2	-3	-3	-2	0	0	-2		-27	/4	-7
													sum			
% Population Exposed	*	*	*	*	*	*	*	*	*	*	*	*	0			
Screen Efficiency/Predati	*	*	*	*	*	*	*	*	*	*	*	*	0			
Handling/Trucking Losse	*	*	*	*	*	*	*	*	*	*	*	*	0			
CCFB Predation Losses	*	*	*	*	*	*	*	*	*	*	*	*	0			
Interior Delta Survival	0	0	-1	-1	1	-1	0	-2	-3	0	0	0		-7	na	-7
													sum			
Flow Distribution	0	0	-1	-1	1	0	1	1	0	0	0	0	1			
Cross Channel Operation	0	0	0	0	0	0	0	0	0	0	0	0	0			
Predation in the Delta	0	0	0	0	0	-1	-1	-1	-1	0	0	0	-4			
Temperature	0	0	0	0	0	0	0	-2	-2	0	0	0	-4			
Salinity	0	0	0	0	0	0	0	0	0	0	0	0	0			
Flows below Hood	-1	-1	-1	-1	-2	-2	-2	-1	-2	0	0	-1		-14	x2	-28
Shallow Water Habitat	0	0	1	1	1	1	0	0	0	0	0	0		4		4
Food Supply	0	0	1	1	1	1	1	1	0	0	0	0		6		6
Ag Diversions	0	0	0	0	0	0	0	0	0	0	0	0		0		0
Adult migration	-2	-2	-1	-1	-2	-2	-1	-2	-2	-1	-1	-2		-19		-19
Toxics (dilution/inputs)	*	*	*	*	*	*	*	*	*	*	*	*		0		0
														-57		-51

ALTERNATIVE 3 (without storage)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep		SUM	Mod	MOD SUM
Entrainment	-2	-3	-3	-2	-2	-2	-3	-3	-2	0	0	-2		-24	/4	-6
													sum			
% Population Exposed	*	*	*	*	*	*	*	*	*	*	*	*	0			
Screen Efficiency/Predati	*	*	*	*	*	*	*	*	*	*	*	*	0			
Handling/Trucking Losse	*	*	*	*	*	*	*	*	*	*	*	*	0			
CCFB Predation Losses	*	*	*	*	*	*	*	*	*	*	*	*	0			
Interior Delta Survival	0	1	1	1	2	0	0	-2	-3	0	0	0		0	na	0
													sum			
Flow Distribution	0	1	1	1	2	1	1	1	0	0	0	0	8			
Cross Channel Operation	0	0	0	0	0	0	0	0	0	0	0	0	0			
Predation in the Delta	0	0	0	0	0	-1	-1	-1	-1	0	0	0	-4			
Temperature	0	0	0	0	0	0	0	-2	-2	0	0	0	-4			
Salinity	0	0	0	0	0	0	0	0	0	0	0	0	0			
Flows below Hood	-1	-1	-1	-1	-2	-2	-2	-1	-2	0	0	-1		-14	x2	-28
Shallow Water Habitat	0	0	1	1	1	1	0	0	0	0	0	0		4		4
Food Supply	0	0	1	1	1	1	1	1	0	0	0	0		6		6
Ag Diversions	0	0	0	0	0	0	0	0	0	0	0	0		0		0
Adult migration	0	0	0	0	0	0	0	0	0	0	0	0		0		0
Toxics	*	*	*	*	*	*	*	*	*	*	*	*		0		0
														-28		-24

ALTERNATIVE 1 (with storage)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep		SUM	Mod	MOD SUM
Entrainment	-1	-2	-3	-3	-3	-3	-2	-2	-1	0	0	-1		-21	/4	-5
													sum			
% Population Exposed	-1	-2	-3	-3	-3	-3	-2	-2	-1	0	0	-1	-21			
Screen Efficiency/Predati	0	0	0	0	0	0	-1	-1	-1	-1	-1	0	-5			
Handling/Trucking Losse	0	0	0	0	0	0	0	-1	-1	-1	-1	-1	-5			
CCFB Predation Losses	0	0	0	0	0	0	0	0	0	0	0	0	0			
Interior Delta Survival	-3	-4	-6	-4	-2	-3	-1	-3	-4	0	0	-1		-31	na	-31
													sum			
Flow Distribution	-2	-3	-5	-4	-2	-2	0	0	-1	0	0	-1	-20			
Cross Channel Operation	-1	-1	-1	0	0	0	0	0	-1	0	0	0	-4			
Predation in the Delta	0	0	0	0	0	-1	-1	-1	0	0	0	0	-3			
Temperature	0	0	0	0	0	0	0	-2	-2	0	0	0	-4			
Salinity	0	0	0	0	0	0	0	0	0	0	0	0	0			
Flows below Hood	0	0	0	0	0	0	-1	0	-1	0	0	0		-2	x2	-4
Shallow Water Habitat	0	0	1	1	1	1	0	0	0	0	0	0		4		4
Food Supply	0	0	1	1	1	1	1	1	0	0	0	0		6		6
Ag Diversions	0	0	0	0	0	0	0	0	0	0	0	0		0		0
Adult Migration	0	0	0	0	0	0	0	0	0	0	0	0		0		0
Toxics (dilution/inputs)	*	*	*	*	*	*	*	*	*	*	*	*		0		0
													TOTAL	-44		-30

ALTERNATIVE 2 (with storage)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep		SUM	Mod	MOD SUM
Entrainment	-2	-4	-5	-4	-3	-3	-3	-3	-2	0	0	-2		-31	/4	-8
													sum			
% Population Exposed	*	*	*	*	*	*	*	*	*	*	*	*	0			
Screen Efficiency/Predati	*	*	*	*	*	*	*	*	*	*	*	*	0			
Handling/Trucking Losse	*	*	*	*	*	*	*	*	*	*	*	*	0			
CCFB Predation Losses	*	*	*	*	*	*	*	*	*	*	*	*	0			
Interior Delta Survival	-1	-1	-2	-2	0	-1	0	-2	-3	0	0	0		-12	na	-12
													sum			
Flow Distribution	-1	-1	-2	-2	0	0	1	1	0	0	0	0	-4			
Cross Channel Operation	0	0	0	0	0	0	0	0	0	0	0	0	0			
Predation in the Delta	0	0	0	0	0	-1	-1	-1	-1	0	0	0	-4			
Temperature	0	0	0	0	0	0	0	-2	-2	0	0	0	-4			
Salinity	0	0	0	0	0	0	0	0	0	0	0	0	0			
Flows below Hood	-1	-1	-1	-1	-2	-2	-2	-1	-2	0	0	-1		-14	x2	-28
Shallow Water Habitat	0	0	1	1	1	1	0	0	0	0	0	0		4		4
Food Supply	0	0	1	1	1	1	1	1	0	0	0	0		6		6
Ag Diversions	0	0	0	0	0	0	0	0	0	0	0	0		0		0
Adult migration	-2	-2	-1	-1	-2	-2	-1	-2	-2	-1	-1	-2		-19		-19
Toxics (dilution/inputs)	*	*	*	*	*	*	*	*	*	*	*	*		0		0
														-66		-57

ALTERNATIVE 3 (with storage)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep		SUM	Mod	MOD SUM
Entrainment	-2	-3	-4	-3	-3	-3	-3	-3	-2	0	0	-2		-28	/4	-7
													sum			
% Population Exposed	*	*	*	*	*	*	*	*	*	*	*	*	0			
Screen Efficiency/Predati	*	*	*	*	*	*	*	*	*	*	*	*	0			
Handling/Trucking Losse	*	*	*	*	*	*	*	*	*	*	*	*	0			
CCFB Predation Losses	*	*	*	*	*	*	*	*	*	*	*	*	0			
Interior Delta Survival	0	1	1	1	2	0	0	-2	-3	0	0	0		0	na	0
													sum			
Flow Distribution	0	1	1	1	2	1	1	1	0	0	0	0	8			
Cross Channel Operation	0	0	0	0	0	0	0	0	0	0	0	0	0			
Predation in the Delta	0	0	0	0	0	-1	-1	-1	-1	0	0	0	-4			
Temperature	0	0	0	0	0	0	0	-2	-2	0	0	0	-4			
Salinity	0	0	0	0	0	0	0	0	0	0	0	0	0			
Flows below Hood	-1	-1	-1	-1	-2	-2	-2	-1	-2	0	0	-1		-14	x2	-28
Shallow Water Habitat	0	0	1	1	1	1	0	0	0	0	0	0		4		4
Food Supply	0	0	1	1	1	1	1	1	0	0	0	0		6		6
Ag Diversions	0	0	0	0	0	0	0	0	0	0	0	0		0		0
Adult migration	0	0	0	0	0	0	0	0	0	0	0	0		0		0
Toxics	*	*	*	*	*	*	*	*	*	*	*	*		0		0
														-32		-25

EXISTING CONDITIONS (Baseline)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	sum	SUM
Entrainment	0	0	0	-1	-1	-3	-2	-2	-3	0	0	0		-12
% Population Exposed	0	0	0	-1	-1	-1	-1	-1	-1	0	0	0	-6	
Screen Efficiency/Predati	0	0	0	0	0	0	0	-1	-1	-1	-1	-1	-5	
Handling/Trucking Loss	0	0	0	0	0	0	0	-1	-1	-1	-1	-1	-5	
CCFB Loss	0	0	0	-1	-1	-2	-3	-3	-3	0	0	0	-13	
Interior Delta Survival	0	0	-1	-2	-2	-4	-3	-4	-6	0	0	-1		-23
Flow Distribution	-1	-1	-1	-1	-1	-2	-1	-1	-2	0	0	-1	-12	
Upper Old River Barrier	1	1	0	0	0	0	1	1	0	0	0	0	4	
Predation in the Delta	0	0	0	-1	-1	-2	-2	-2	-1	0	0	0	-9	
Temperature	0	0	0	0	0	0	-1	-2	-3	0	0	0	-6	
Salinity	0	0	0	0	0	0	0	0	0	0	0	0	0	
Flow at Vernalis	-1	-1	-1	-1	-2	-2	-3	-3	-3	0	0	-1		-18
Shallow Water Habitat	0	0	0	0	0	0	0	0	0	0	0	0		0
Food Supply	0	0	0	0	0	0	0	0	0	0	0	0		0
Ag Diversions	0	0	0	0	0	0	-1	-1	-1	0	0	0		-3
Adult Migration	na	na	na	na	na	na	na	na	na	na	na	na		0
Toxics (dilution/inputs)	*	*	*	*	*	*	*	*	*	*	*	*		0
													TOTAL	-56

NO ACTION ALTERNATIVE

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	sum	SUM
Entrainment	0	0	0	-1	-2	-3	-2	-2	-3	0	0	0		-13
% Population Exposed	*	*	*	*	*	*	*	*	*	*	*	*	0	
Screen Efficiency/Predati	*	*	*	*	*	*	*	*	*	*	*	*	0	
Handling/Trucking Losse	*	*	*	*	*	*	*	*	*	*	*	*	0	
CCFB Losses	*	*	*	*	*	*	*	*	*	*	*	*	0	
Interior Delta Survival	0	0	-1	-3	-3	-4	-3	-4	-6	0	0	-1		-25
Flow Distribution	-1	-1	-1	-2	-2	-2	-1	-1	-2	0	0	-1	-14	
Upper Old River Barrier	1	1	0	0	0	0	1	1	0	0	0	0	4	
Predation in the Delta	0	0	0	-1	-1	-2	-2	-2	-1	0	0	0	-9	
Temperature	0	0	0	0	0	0	-1	-2	-3	0	0	0	-6	
Salinity	0	0	0	0	0	0	0	0	0	0	0	0	0	
Flow at Vernalis	-1	-1	-1	-1	-2	-2	-3	-3	-3	0	0	-1		-18
Shallow Water Habitat	0	0	0	0	0	0	0	0	0	0	0	0		0
Food Supply	0	0	0	0	0	0	0	0	0	0	0	0		0
Ag Diversions	0	0	0	0	0	0	-1	-1	-1	0	0	0		-3
Adult Migration	na	na	na	na	na	na	na	na	na	na	na	na		0
Toxics (dilution/inputs)	*	*	*	*	*	*	*	*	*	*	*	*		0
													TOTAL	-59

COMMON PROGRAMS

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	sum	SUM
Entrainment	0	0	0	-1	-2	-3	-2	-2	-3	0	0	0		-13
% Population Exposed	*	*	*	*	*	*	*	*	*	*	*	*	0	
Screen Efficiency/Predati	*	*	*	*	*	*	*	*	*	*	*	*	0	
Handling/Trucking Losse	*	*	*	*	*	*	*	*	*	*	*	*	0	
CCFB Losses	*	*	*	*	*	*	*	*	*	*	*	*	0	
Interior Delta Survival	0	0	-1	-2	-2	-3	-2	-3	-5	0	0	-1		-19
Flow Distribution	-1	-1	-1	-2	-2	-2	-1	-1	-2	0	0	-1	-14	
Upper Old River Barrier	1	1	0	0	0	0	1	1	0	0	0	0	4	
Predation in the Delta	0	0	0	0	0	-1	-1	-1	0	0	0	0	-3	
Temperature	0	0	0	0	0	0	-1	-2	-3	0	0	0	-6	
Salinity	0	0	0	0	0	0	0	0	0	0	0	0	0	
Flow at Vernalis	-1	-1	-1	-1	-2	-2	-3	-2	-3	0	0	-1		-17
Shallow Water Habitat	0	0	0	1	1	1	0	0	0	0	0	0		3
Food Supply	0	0	0	1	1	1	1	1	0	0	0	0		5
Ag Diversions	0	0	0	0	0	0	0	0	0	0	0	0		0
Adult Migration	na	na	na	na	na	na	na	na	na	na	na	na		0
Toxics (dilution/inputs)	*	*	*	*	*	*	*	*	*	*	*	*		0
													TOTAL	-41

ALTERNATIVE 1 (without storage)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	sum	SUM
Entrainment	0	0	0	0	-1	-2	-1	-1	-2	0	0	0		-7
% Population Exposed	*	*	*	*	*	*	*	*	*	*	*	*	0	
Screen Efficiency/Predati	*	*	*	*	*	*	*	*	*	*	*	*	0	
Handling/Trucking Losse	*	*	*	*	*	*	*	*	*	*	*	*	0	
CCFB Losses	*	*	*	*	*	*	*	*	*	*	*	*	0	
Interior Delta Survival	0	0	-1	-2	-2	-3	-2	-3	-5	0	0	-1		-19
Flow Distribution	-1	-1	-1	-2	-2	-2	-1	-1	-2	0	0	-1	-14	
Upper Old River Barrier	1	1	0	0	0	0	1	1	0	0	0	0	4	
Predation in the Delta	0	0	0	0	0	-1	-1	-1	0	0	0	0	-3	
Temperature	0	0	0	0	0	0	-1	-2	-3	0	0	0	-6	
Salinity	0	0	0	0	0	0	0	0	0	0	0	0	0	
Flow at Vernalis	-1	-1	-1	-1	-2	-2	-3	-2	-3	0	0	-1		-17
Shallow Water Habitat	0	0	0	1	1	1	0	0	0	0	0	0		3
Food Supply	0	0	0	1	1	1	1	1	0	0	0	0		5
Ag Diversions	0	0	0	0	0	0	0	0	0	0	0	0		0
Adult Migration	na	na	na	na	na	na	na	na	na	na	na	na		0
Toxics (dilution/inputs)	*	*	*	*	*	*	*	*	*	*	*	*		0
													TOTAL	-35

ATERNATIVE 2 (without storage)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	sum	SUM
Entrainment	0	0	0	0	-1	-2	-1	-1	-2	0	0	0		-7
% Population Exposed	*	*	*	*	*	*	*	*	*	*	*	*	0	
Screen Efficiency/Predati	*	*	*	*	*	*	*	*	*	*	*	*	0	
Trucking/Handling Losse	*	*	*	*	*	*	*	*	*	*	*	*	0	
CCFB Losses	*	*	*	*	*	*	*	*	*	*	*	*	0	
Interior Delta Survival	1	1	0	0	1	0	-1	-2	-2	0	0	0		-2
Flow Distribution	0	0	0	0	1	1	0	0	1	0	0	0	3	
Upper Old River Barrier	1	1	0	0	0	0	1	1	0	0	0	0	4	
Predation in the Delta	0	0	0	0	0	-1	-1	-1	0	0	0	0	-3	
Temperature	0	0	0	0	0	0	-1	-2	-3	0	0	0	-6	
Salinity	0	0	0	0	0	0	0	0	0	0	0	0	0	
Flow at Vernalis	-1	-1	-1	-1	-2	-2	-3	-2	-3	0	0	-1		-17
Shallow Water Habitat	0	0	0	1	1	1	0	0	0	0	0	0		3
Food Supply	0	0	0	1	1	1	1	1	0	0	0	0		5
Ag Diversions	0	0	0	0	0	0	0	0	0	0	0	0		0
Adult Migration	na	na	na	na	na	na	na	na	na	na	na	na		0
Toxics (dilution/inputs)	*	*	*	*	*	*	*	*	*	*	*	*		0
													TOTAL	-18

ALTERNATIVE 3 (without storage)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	sum	SUM
Entrainment	0	0	0	0	0	-1	0	0	-1	0	0	0		-2
% Population Exposed	*	*	*	*	*	*	*	*	*	*	*	*	0	
Screen Efficiency/Predati	*	*	*	*	*	*	*	*	*	*	*	*	0	
Handling/Trucking Losse	*	*	*	*	*	*	*	*	*	*	*	*	0	
CCFB losses	*	*	*	*	*	*	*	*	*	*	*	*	0	
Interior Delta Survival	2	2	1	2	3	2	1	0	0	0	0	1		14
Flow Distribution	1	1	1	2	3	3	2	2	3	0	0	1	19	
Upper Old River Barrier	1	1	0	0	0	0	1	1	0	0	0	0	4	
Predation in the Delta	0	0	0	0	0	-1	-1	-1	0	0	0	0	-3	
Temperature	0	0	0	0	0	0	-1	-2	-3	0	0	0	-6	
Salinity	0	0	0	0	0	0	0	0	0	0	0	0	0	
Flow at Vernalis	-1	-1	-1	-1	-2	-2	-3	-2	-3	0	0	-1		-17
Shallow Water Habitat	0	0	0	1	1	1	0	0	0	0	0	0		3
Food Supply	0	0	0	1	1	1	1	1	0	0	0	0		5
Ag Diversions	0	0	0	0	0	0	0	0	0	0	0	0		0
Adult Migration	na	na	na	na	na	na	na	na	na	na	na	na		0
Toxics (dilution/inputs)	*	*	*	*	*	*	*	*	*	*	*	*		0
													TOTAL	3

ALTERNATIVE 1 (with storage)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	sum	SUM
Entrainment	0	0	0	-1	-2	-3	-1	-1	-2	0	0	0		-10
% Population Exposed	*	*	*	*	*	*	*	*	*	*	*	*	0	
Screen Efficiency/Predati	*	*	*	*	*	*	*	*	*	*	*	*	0	
Handling/Trucking Losse	*	*	*	*	*	*	*	*	*	*	*	*	0	
CCFB Losses	*	*	*	*	*	*	*	*	*	*	*	*	0	
Interior Delta Survival	0	0	-1	-3	-3	-4	-2	-3	-5	0	0	-1		-22
Flow Distribution	-1	-1	-1	-3	-3	-3	-1	-1	-2	0	0	-1	-17	
Upper Old River Barrier	1	1	0	0	0	0	1	1	0	0	0	0	4	
Predation in the Delta	0	0	0	0	0	-1	-1	-1	0	0	0	0	-3	
Temperature	0	0	0	0	0	0	-1	-2	-3	0	0	0	-6	
Salinity	0	0	0	0	0	0	0	0	0	0	0	0	0	
Flow at Vernalis	-1	-1	-1	-1	-2	-2	-3	-2	-3	0	0	-1		-17
Shallow Water Habitat	0	0	0	1	1	1	0	0	0	0	0	0		3
Food Supply	0	0	0	1	1	1	1	1	0	0	0	0		5
Ag Diversions	0	0	0	0	0	0	0	0	0	0	0	0		0
Adult Migration	na	na	na	na	na	na	na	na	na	na	na	na		0
Toxics (dilution/inputs)	*	*	*	*	*	*	*	*	*	*	*	*		0
													TOTAL	-41

ALTERNATIVE 2 (with storage)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	sum	SUM
Entrainment	0	0	0	-1	-2	-3	-1	-1	-2	0	0	0		-10
% Population Exposed	*	*	*	*	*	*	*	*	*	*	*	*	0	
Screen Efficiency/Predati	*	*	*	*	*	*	*	*	*	*	*	*	0	
Trucking/Handling Losse	*	*	*	*	*	*	*	*	*	*	*	*	0	
CCFB Losses	*	*	*	*	*	*	*	*	*	*	*	*	0	
Interior Delta Survival	1	1	0	-1	0	-1	-1	-2	-2	0	0	0		-5
Flow Distribution	0	0	0	-1	0	0	0	0	1	0	0	0	0	
Upper Old River Barrier	1	1	0	0	0	0	1	1	0	0	0	0	4	
Predation in the Delta	0	0	0	0	0	-1	-1	-1	0	0	0	0	-3	
Temperature	0	0	0	0	0	0	-1	-2	-3	0	0	0	-6	
Salinity	0	0	0	0	0	0	0	0	0	0	0	0	0	
Flow at Vernalis	-1	-1	-1	-1	-2	-2	-3	-2	-3	0	0	-1		-17
Shallow Water Habitat	0	0	0	1	1	1	0	0	0	0	0	0		3
Food Supply	0	0	0	1	1	1	1	1	0	0	0	0		5
Ag Diversions	0	0	0	0	0	0	0	0	0	0	0	0		0
Adult Migration	na	na	na	na	na	na	na	na	na	na	na	na		0
Toxics (dilution/inputs)	*	*	*	*	*	*	*	*	*	*	*	*		0
													TOTAL	-24

ALTERNATIVE 3 (with storage)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	sum	SUM
Entrainment	0	0	0	0	0	-1	0	0	-1	0	0	0		-2
% Population Exposed	*	*	*	*	*	*	*	*	*	*	*	*	0	
Screen Efficiency/Predati	*	*	*	*	*	*	*	*	*	*	*	*	0	
Handling/Trucking Losse	*	*	*	*	*	*	*	*	*	*	*	*	0	
CCFB losses	*	*	*	*	*	*	*	*	*	*	*	*	0	
Interior Delta Survival	2	2	1	2	3	2	1	0	0	0	0	1		14
Flow Distribution	1	1	1	2	3	3	2	2	3	0	0	1	19	
Upper Old River Barrier	1	1	0	0	0	0	1	1	0	0	0	0	4	
Predation in the Delta	0	0	0	0	0	-1	-1	-1	0	0	0	0	-3	
Temperature	0	0	0	0	0	0	-1	-2	-3	0	0	0	-6	
Salinity	0	0	0	0	0	0	0	0	0	0	0	0	0	
Flow at Vernalis	-1	-1	-1	-1	-2	-2	-3	-2	-3	0	0	-1		-17
Shallow Water Habitat	0	0	0	1	1	1	0	0	0	0	0	0		3
Food Supply	0	0	0	1	1	1	1	1	0	0	0	0		5
Ag Diversions	0	0	0	0	0	0	0	0	0	0	0	0		0
Adult Migration	na	na	na	na	na	na	na	na	na	na	na	na		0
Toxics (dilution/inputs)	*	*	*	*	*	*	*	*	*	*	*	*		0
													TOTAL	3

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